(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 693 727 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.01.1996 Bulletin 1996/04

(51) Int. Cl.^{6}: G06F 12/08

(21) Application number: 95304789.1

(22) Date of filing: 10.07.1995

(84) Designated Contracting States:
AT DE FR GB IT NL

(30) Priority: 20.07.1994 JP 189895/94

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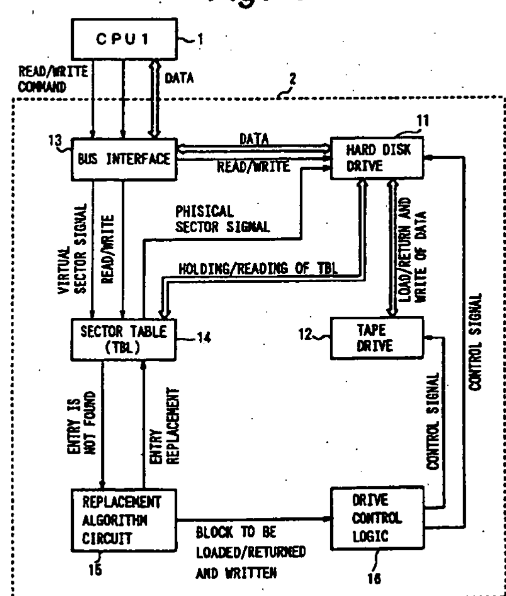
(54) **Information storage device comprising a magnetic tape recorder and a hard disc drive**

(57) An information storage device includes a sequential access storage medium (12) and a randomly accessed storage medium (11). Data from the sequential access medium is loaded to the randomly accessed medium. When an external device (1) accesses the information storage device, data is, in fact, accessed from the randomly accessed storage medium, even though, as seen from the perspective of the external device, the selected data is apparently accessed directly from the sequential access storage medium.

Fig. 1



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Description

The present invention relates to an information storage device and, in particular, to but not exclusively, an information storage device that includes a magnetic tape recording medium used in connection with a random access recording medium, such as a hard disk drive.

In a previously proposed digital VTR system, a digitised video signal is compressed in accordance with a DCT (Discrete Cosine Transform) technique. This compressed digital video signal is recorded onto the oblique tracks of a magnetic tape. Each track is provided with a subcode area for storing a track number. The VTR system manages the recorded data in accordance with these track numbers. Furthermore, the capacity of such a magnetic medium to record digital data permits such a medium to record information signals in addition to the digital video.

Although such a magnetic tape provides a large storage capacity, when compared with other recording mediums, accessing the information recorded thereon is slow because a magnetic tape is essentially a sequential access medium. That is, in order to read data recorded at a predetermined position of the tape, the reading device must physically wind or unwind the tape to this predetermined position.

The present invention addresses the problem of providing an information storage device in which information on a sequential access recording medium can be randomly accessed.

Aspects of the present invention are set out in the accompanying claims.

In accordance with at least a preferred embodiment of this invention, an information storage device includes a sequential access storage means and a random access storage means. Information recorded in the sequential access storage means is loaded into the random access storage means. When an external device extracts selected data from the information storage device, it first transmits to the storage device a first data location marker, which is indicative of a physical location on the sequential access storage means that includes the selected data. On the basis of this first data location marker, the information storage device finds a previously stored second data location marker. This second data location marker is indicative of a location on the random access storage medium in which is recorded the same selected data. This selected data is then read out in a random manner from the information storage medium. Thus, the present invention provides a recording medium with a large storage capacity, such as a magnetic tape, that can be randomly accessed when the tape is used in conjunction with a random access storage medium, such as a hard disk drive.

Various other objects, advantages and features of the present invention will become readily apparent from the ensuing detailed description, and the novel features will be particularly pointed out in the appended claims.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 illustrates the information storage device of one embodiment of the present invention;
Fig. 2A illustrates the arrangement of data blocks in the hard disk drive of the information storage device;
Fig. 2B illustrates the arrangement of data blocks in the magnetic medium of the information storage device;
Fig. 3 is an exemplary illustration of the contents of the sector table memory of the information storage device;
Figs. 4 and 5 are intended to be viewed together, and they illustrate a flow diagram indicative of a data access operation of one embodiment of the present invention;
Fig. 6 illustrates a flow diagram indicative of a tape ejection process of one embodiment of the present invention;
Fig. 7 illustrates a flow diagram indicative of an initialization of the information storage device of one embodiment of the present invention; and
Fig. 8 illustrates a video broadcast reception system that employs the information storage device of one embodiment of the present invention.

Fig. 1 illustrates an information storage device 2 in accordance with one embodiment of the present invention. The hard disk drive 11 is used for recording data to a fixed magnetic disk (not shown) of a relatively large capacity. This recorded data is accessed randomly from the magnetic disk. The tape drive 12 is capable of driving, for example, a tape cassette of a digital VTR. A different track number is assigned to and recorded in a subcode area of each track. As explained before, data recorded on this tape can be managed in accordance with these track numbers. For simplicity, data that is recorded on the digital VTR cassette shall be regarded as recorded in tape drive 12.

Before proceeding to the remaining elements of Fig. 1, the discussion shall momentarily turn to Figs. 2A and 2B, which describe the organization of data in hard disk drive 11 and tape drive 12. Fig. 2B illustrates a magnetic tape comprising a plurality of oblique tracks. Each track has a storage capacity of 13.65 Kbytes, and each one of blocks b1, b2, b3, etc., comprises 1,200 of such consecutive tracks. Fig. 2A illustrates the arrangement of data recorded on hard disk drive 11. Each block B1, B2, B3, etc., recorded in hard disk drive 11, is arranged to have a one-to-one correspondence with blocks b1, b2, b3, etc., of tape drive 12. The storage capacity of each block in hard-disk drive 11 is the same as the storage capacity of each block in tape drive 12, namely, 16 Mbytes. Therefore, assuming that the storage capacity of the hard disk drive is 256 Mbytes, hard disk drive 11 can store up to 16 of such blocks. Moreover, assuming that each physical sector of hard disk drive 11 comprises 4 Kbytes, then

each block of hard disk drive comprises 4,096 sectors. A sector denotes the minimum unit of data that is read out or written to hard disk drive 11.

As an initial matter, before any data is read from information storage device 2, the data already recorded on tape drive 12 is first loaded to hard disk drive 11. During this initialization, a copy of each block of data, together with the tape location of each block, is written to hard disk drive 12.

The bus interface 13 is used to connect a bus of the CPU 1 and the storage device 2. Data to be recorded or reproduced is supplied between CPU 1 and storage device 2 through bus interface 13. When accessing storage device 2, CPU 1 designates a virtual sector number which corresponds to a portion of the magnetic tape on which is recorded the desired data. CPU 1 then generates a read/write command which is supplied through bus interface 13.

The sector table (TBL) 14 is a table indicative of a corresponding relation between the virtual sector number and the physical sector number on the hard disk drive 11. The sector table 14 determines which data from tape drive 12 has been loaded to hard disk drive 11, and it also determines whether a match exists between data on the hard disk drive 11 and data on the tape drive 12.

The replacement algorithm circuit 15 judges which portion of the data held in the tape drive 12 should be loaded to the hard disk drive 11, and it also decides which data of the hard disk drive 11 is to be deleted in order to make room for data that has been selected to be reproduced from tape drive 12.

The drive control logic 16 instructs the hard disk 11 and tape drive 12 to exchange the data between them when it is necessary to replace the block loaded in the hard disk drive 11. CPU 1 accesses data from storage device 2 by supplying a virtual sector number to bus interface 13. Bus interface 13 then supplies the virtual sector number to the sector table 14. Sector table 14 then checks whether the block corresponding to the supplied virtual sector number has already been loaded from the tape drive 12 onto the hard disk drive 11. In order to access the selected data, the sector table 14 provides a physical sector number that corresponds to the virtual sector number. This physical sector number indicates the location on hard disk drive 11 of the selected block number. The hard disk drive 11 is accessed by the obtained physical sector and the data is inputted/outputted between the CPU 1 and the hard disk drive 11 through the bus interface 13.

If the block corresponding to the supplied virtual sector number has not been loaded to hard disk drive 11, replacement algorithm circuit 15 reserves a physical sector number on hard disk drive 11 for this block. Sector table 14 is consequently updated to store the correspondence between the supplied virtual sector number and the newly reserved physical sector number. The tape drive 12 is then moved to the position of the block corresponding to the supplied virtual sector number and the data of this block is loaded from the tape drive 12 onto the hard disk drive 11. The physical sector number of the hard disk drive 11 corresponding to the virtual sector number is obtained by using the sector table 14. The hard disk drive 11 is accessed by the obtained physical sector number and the data is inputted/outputted between the CPU 1 and the hard disk drive 11 through the bus interface 13.

According to the embodiment of the invention as mentioned above, the data in the tape drive 12 is once loaded into the hard disk drive 11. The virtual sector number is inputted from the CPU 1 side. By such an operation, although the hard disk drive 11 is actually accessed, when it is seen from the CPU 1 side, it is seen as if the tape drive 12 was directly accessed. Consequently, the storage device of a large capacity which can be accessed at random can be realized.

Fig. 3 shows an example of the sector table 14 which may comprise a volatile memory. As stated before, sector table 14 establishes a correspondence between the blocks recorded on hard disk drive 11 and tape drive 12 and between the physical sector numbers of hard disk drive 11 and the virtual sector numbers of tape drive 12. The Rewrite flag is a flag indicating whether the data has been rewritten or not. When the flag is set to "1", it indicates that the data has been rewritten. When it is set to "0", it denotes that the data has not been rewritten.

Figs. 4 and 5 show an algorithm for processes which are executed when there is a request to access the data.

A virtual sector number (vs) of the data to be accessed and information regarding whether the data is read or written are checked (step ST1). This is equivalent to a process to check whether the data to be accessed has already been loaded to the hard disk.

When the data exists, a physical sector number (ps) corresponding to the virtual sector number (vs) is read from sector table 14 (step ST2). A check is made to see if the data is to be read or written (step ST3). Data to be read out is read from the hard disk drive 11 (step ST4). Data to be written is written into the hard disk 11 (step ST5). When the data is written, the Rewrite flag is set to "1" at an entry of the sector table 14 that corresponds to the block that includes the written data (step ST6).

If the data to be accessed has not been loaded on the hard disk 11 in step ST1, it is necessary to newly load a block that includes the sector to be accessed from the tape drive 12 to the hard disk 11. Since the number of blocks which can be loaded on the hard disk 11 is constant, when all entries in the sector table 14 are occupied, one of the blocks on the hard disk drive 11 is deleted and the block to be accessed is loaded at the location of the deleted block.

In this case, replacement algorithm circuit 15 selects, from among the entries in sector table 14, the block that is used the least to replace the deleted block (step ST7). A check is made to see if the Rewrite flag has been set in the block (step ST8). If the Rewrite flag has been set, the data of the block is returned and written to the tape (step ST9).

Subsequently, the block is loaded to the reserved location (step ST10) and the sector table is updated (step ST11). The contents of the sector table are copied onto the hard disk for preparation of a shut-off of the power source (step ST12). After that, the processing routine advances to step ST2.

Fig. 6 shows an algorithm when the tape is ejected from the tape drive. A check is made to see whether an entry exists in the sector table (step ST21). If YES, the entry is picked up (step ST22). A check is made to see if the Rewrite flag has been set to "1" (step ST23). If the Rewrite flag has been set to "1", the data of the block is returned and written onto the tape (step ST24) and the entry is deleted (step ST25). When the Rewrite flag is not set to "1", the entry is deleted. As mentioned above, among the entries of the blocks in the sector table 14, all blocks in which the Rewrite flags were set to "1" are returned and written to the tape. When all of the blocks are returned and written to the tape, the contents of the table are stored into the hard disk drive (step ST26) and, after that, the tape is ejected (step ST27).

Fig. 7 shows an algorithm when the power source is turned on. When the power source is turned on, the contents of the table are read out from the hard disk drive (step ST31) to the sector table 14.

Fig. 8 illustrates a digital video system 20 that includes the storage device 25 of one embodiment of the present invention. Satellite dish 21 receives a digital video signal compressed in accordance with the MPEG compression technique. The received video signal is tuned by tuner 22 and descrambled by descrambler 23. When a user wishes to record the incoming video signal, switch 24 supplies the video signal to storage device 2. In order to reproduce the stored video signal for viewing, the storage device 2 supplies the video signal to decoder 26, which supplies the decoded video signal to a television monitor (not shown). When a user merely wishes to watch a currently broadcast program without recording it, switch 24 supplies the descrambled video signal directly to decoder 26.

While the present invention has been particularly shown and described with reference to the preferred embodiments, it will be readily appreciated by those of ordinary skill in the art that various changes and modifications may be made without departing from the scope of the invention. For example, any storage device, such as a magneto-optic disk drive, can be used in place of the hard disk drive 11, so long as the device can be accessed at random and has a relatively large capacity. It is intended that the appended claims be interpreted as covering the embodiments described herein and all equivalents thereto.

Claims

1. An information storage device (2) for storing a plurality of data items, comprising:

   first storage means (12) for storing said plurality of data items in association with a first plurality of data location markers;

   second storage means (11), in communication with said first storage means, for storing at least a portion of said plurality of data items in association with a second plurality of data location markers;

   input means (13) for receiving a data item location signal corresponding to at least a portion of said first plurality of data location markers;

   table means (14), in communication with said input means, for obtaining at least a portion of said second plurality of data location markers corresponding to said data item location signal;

   control means (13), in communication with said input means, first storage means, and second storage means, for loading said at least a portion of said data items from said first storage means to said second storage means and for reading from said second storage means data items corresponding to said obtained portion of said second plurality of data location markers.

2. The information storage device of Claim 1, wherein said plurality of data items includes at least video data items.

3. The information storage device of Claim 2, wherein said video data items are compressed in accordance with a predetermined compression technique.

4. The information storage device of Claim 1, wherein said first storage means comprises a magnetic tape medium and wherein said second storage means comprises a magnetic hard disk.

5. The information storage device of Claim 1, wherein said first plurality of data location markers comprises a plurality of virtual sector numbers and wherein said second plurality of data location markers comprises a plurality of physical sector numbers.

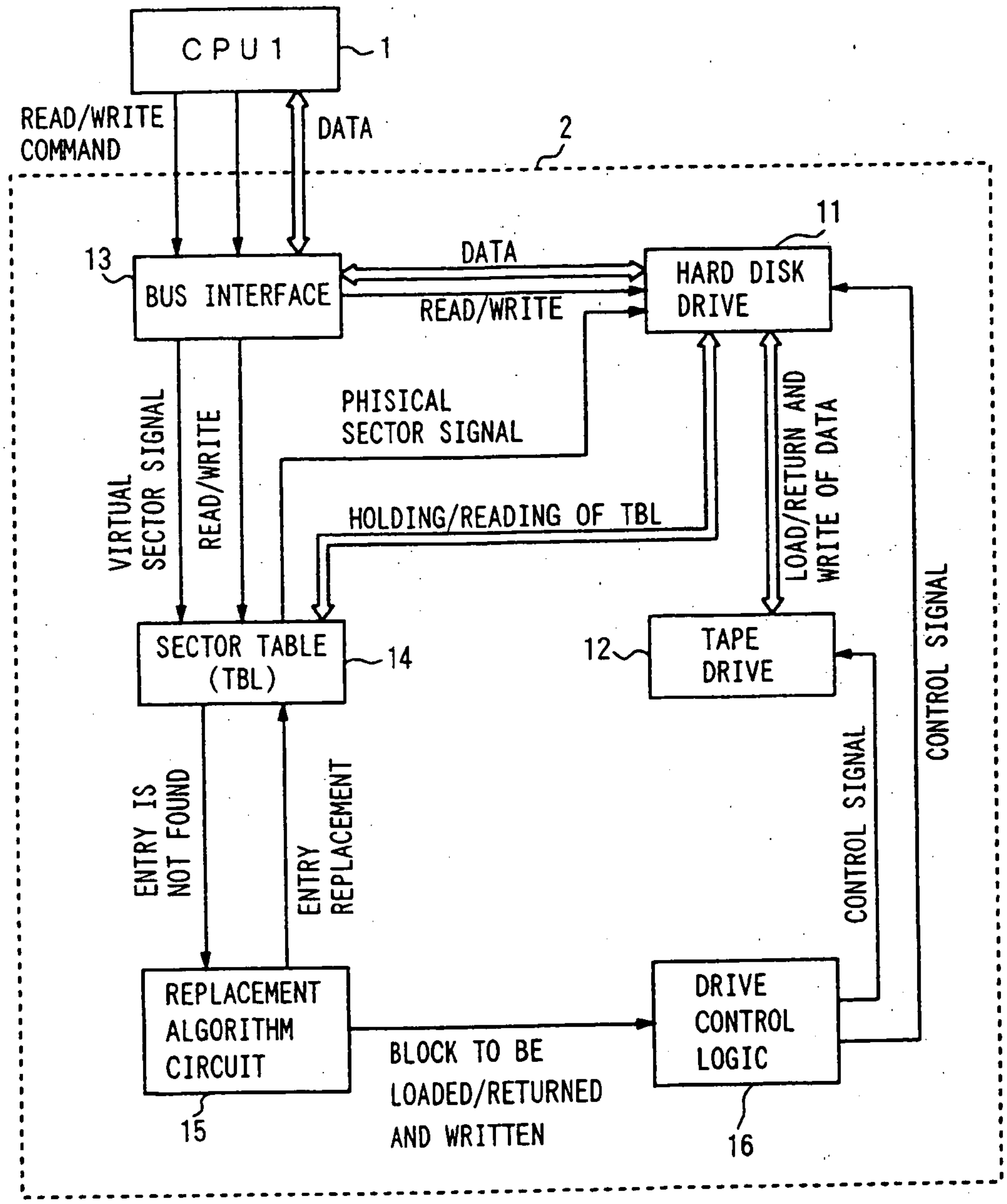
6. A method of accessing a plurality of data items stored in an information storage device, said information storage device including a first storage means and a second storage means, said method comprising the steps of:

   storing said plurality of data items in said first storage means;

   loading at least a portion of said plurality of data items from said first storage means to said second storage means;

   reading said at least a portion of said plurality of data items from said second storage means.

Fig. 1


CPU1
1
READ/WRITE COMMAND
DATA
2
11
13
DATA
BUS INTERFACE
HARD DISK DRIVE
READ/WRITE
PHISICAL SECTOR SIGNAL
VIRTUAL SECTOR SIGNAL
READ/WRITE
HOLDING/READING OF TBL
LOAD/RETURN AND WRITE OF DATA
CONTROL SIGNAL
SECTOR TABLE (TBL)
14
12
TAPE DRIVE
ENTRY IS NOT FOUND
ENTRY REPLACEMENT
CONTROL SIGNAL
REPLACEMENT ALGORITHM CIRCUIT
DRIVE CONTROL LOGIC
BLOCK TO BE LOADED/RETURNED AND WRITTEN
15
16

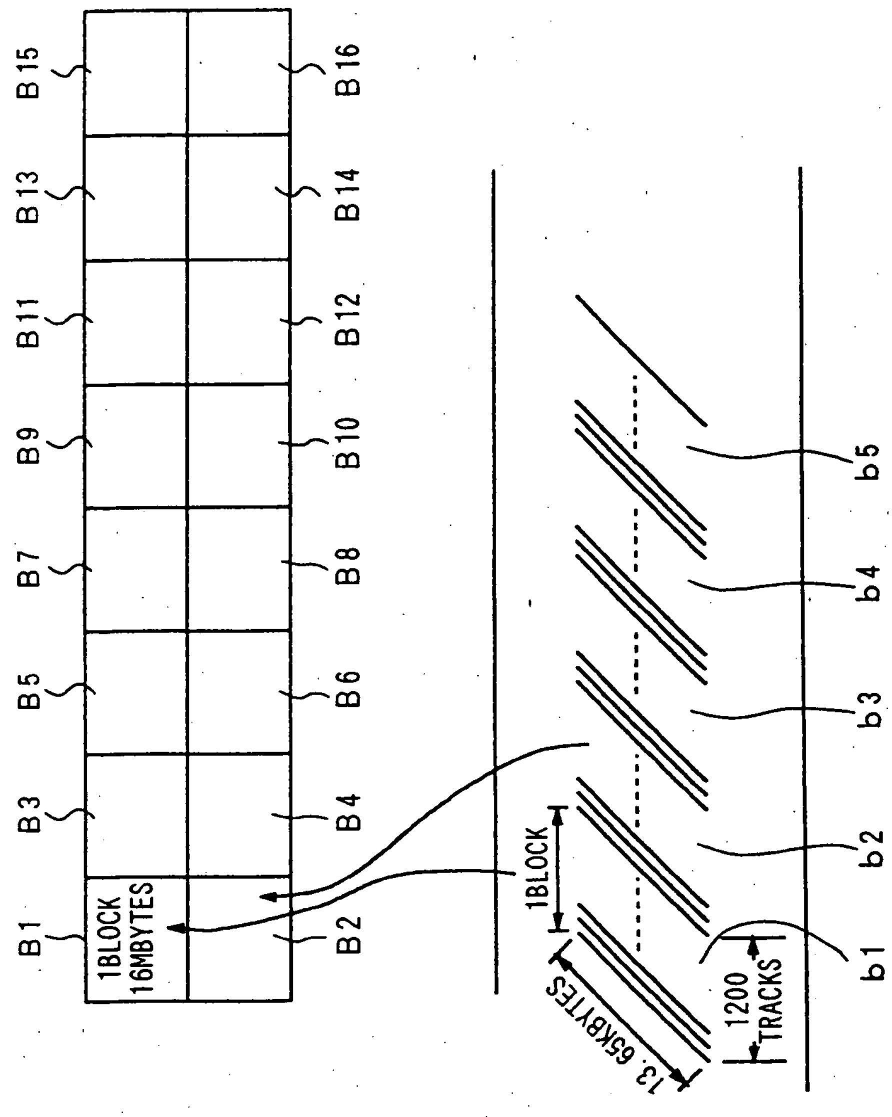

B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
1BLOCK
16MBYTES
1BLOCK
13.65KBYTES
1200
TRACKS
b1
b2
b3
b4
b5

Fig. 2A

Fig. 2B

Fig. 3

BLOCK NUMBER ON HARD DISK	BLOCK NUMBER ON TAPE	REWRITE FLAG	START AND END OF PHYSICAL SECTOR NUMBER	START AND END OF VIRTUAL SECTOR NUMBER	1ST TRACK ID ON TAPE
0	56	1	0 4095	229376 233471	67200 68399
1	3	0	4096 8191	12288 16383	3600 4799
2	1	0	8192 12287	4096 8191	1200 2399
3	19	0	12288 16383	77824 81919	22800 23999
4	28	0	16384 20479	114688 118783	33600 34799
5	54	1	20480 24575	221184 225279	64800 65999
6	30	0	24576 28671	122880 126975	36000 37199
7	29	1	28672 32767	118784 122879	34800 35999
8	22	0	32768 36863	90112 94207	26400 27599
9	38	1	36864 40959	115648 159743	45600 46799
10	47	0	40960 45055	192512 196607	56400 57599
11	44	0	45056 49151	180224 184319	52800 53999
12	45	0	49152 53247	184320 188415	54000 55199
13	27	0	53248 57343	110592 114687	32400 33599
14	4	0	57344 61439	16384 20479	4800 5999
15	8	1	61439 65535	32768 36863	9600 10799

THE NUMBER OF SECTORS PAR 1 BLOCK ON HARD DISK	THE NUMBER OF TRACKS PAER 1 BLOCK ON TAPE
4096	1200

← MANAGED PORTION → ← PORTION WHICH CAN BE LED OUT EQUIVALENTLY →

Fig. 4

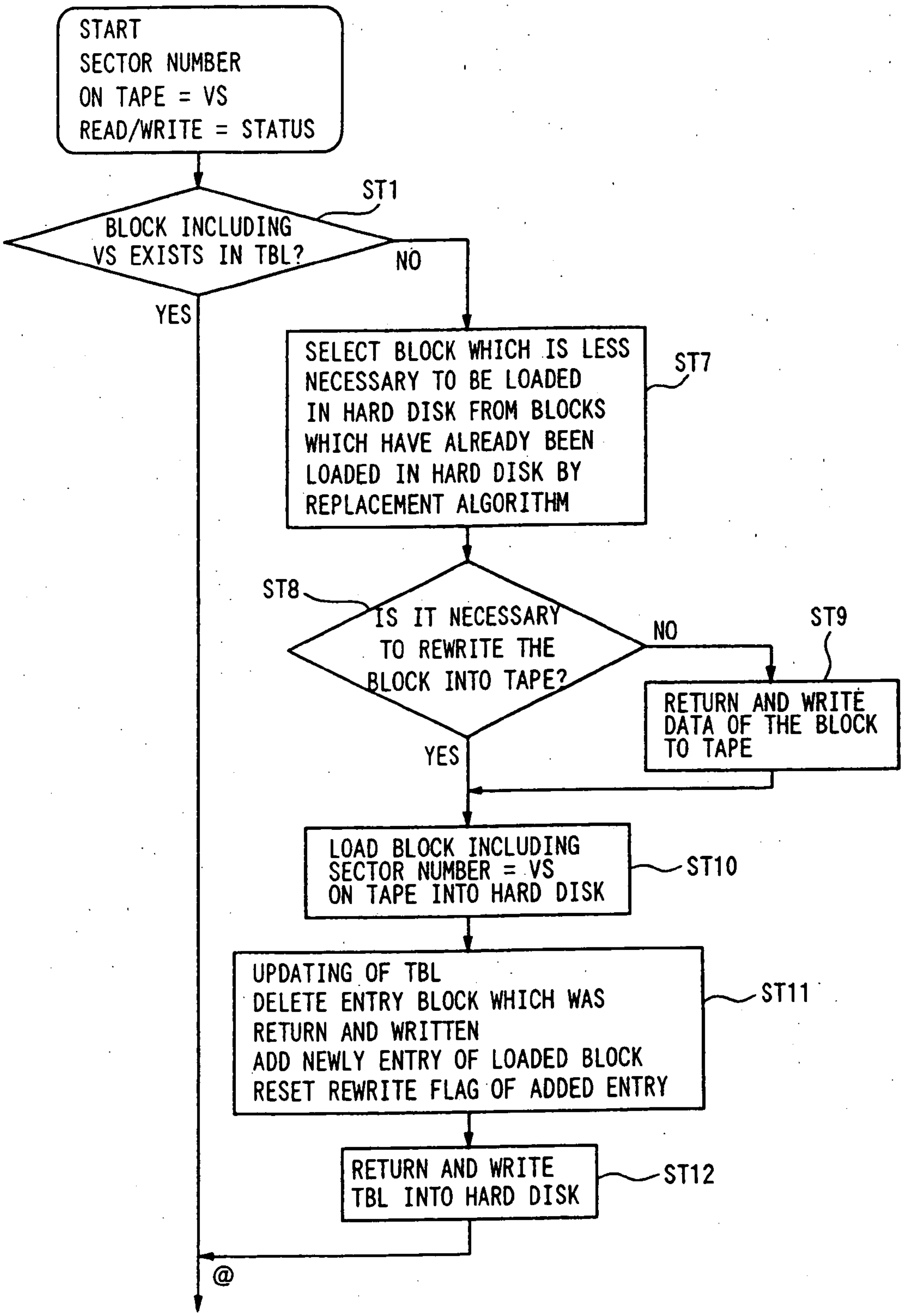

START
SECTOR NUMBER
ON TAPE = VS
READ/WRITE = STATUS
ST1
BLOCK INCLUDING VS EXISTS IN TBL?
NO
YES
SELECT BLOCK WHICH IS LESS NECESSARY TO BE LOADED IN HARD DISK FROM BLOCKS WHICH HAVE ALREADY BEEN LOADED IN HARD DISK BY REPLACEMENT ALGORITHM
ST7
ST8
IS IT NECESSARY TO REWRITE THE BLOCK INTO TAPE?
NO
ST9
RETURN AND WRITE DATA OF THE BLOCK TO TAPE
YES
LOAD BLOCK INCLUDING SECTOR NUMBER = VS ON TAPE INTO HARD DISK
ST10
UPDATING OF TBL
DELETE ENTRY BLOCK WHICH WAS RETURN AND WRITTEN
ADD NEWLY ENTRY OF LOADED BLOCK
RESET REWRITE FLAG OF ADDED ENTRY
ST11
RETURN AND WRITE TBL INTO HARD DISK
ST12
@

Fig. 5

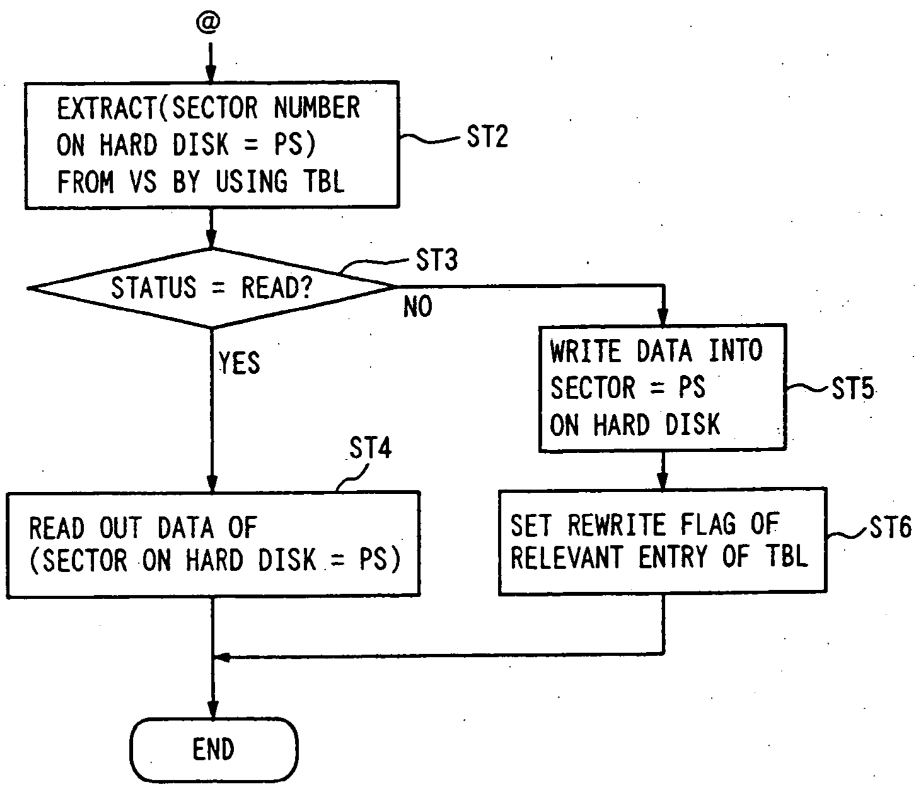

@
EXTRACT(SECTOR NUMBER ON HARD DISK = PS) FROM VS BY USING TBL
ST2
STATUS = READ?
ST3
NO
YES
WRITE DATA INTO SECTOR = PS ON HARD DISK
ST5
ST4
READ OUT DATA OF (SECTOR ON HARD DISK = PS)
SET REWRITE FLAG OF RELEVANT ENTRY OF TBL
ST6
END

Fig. 6

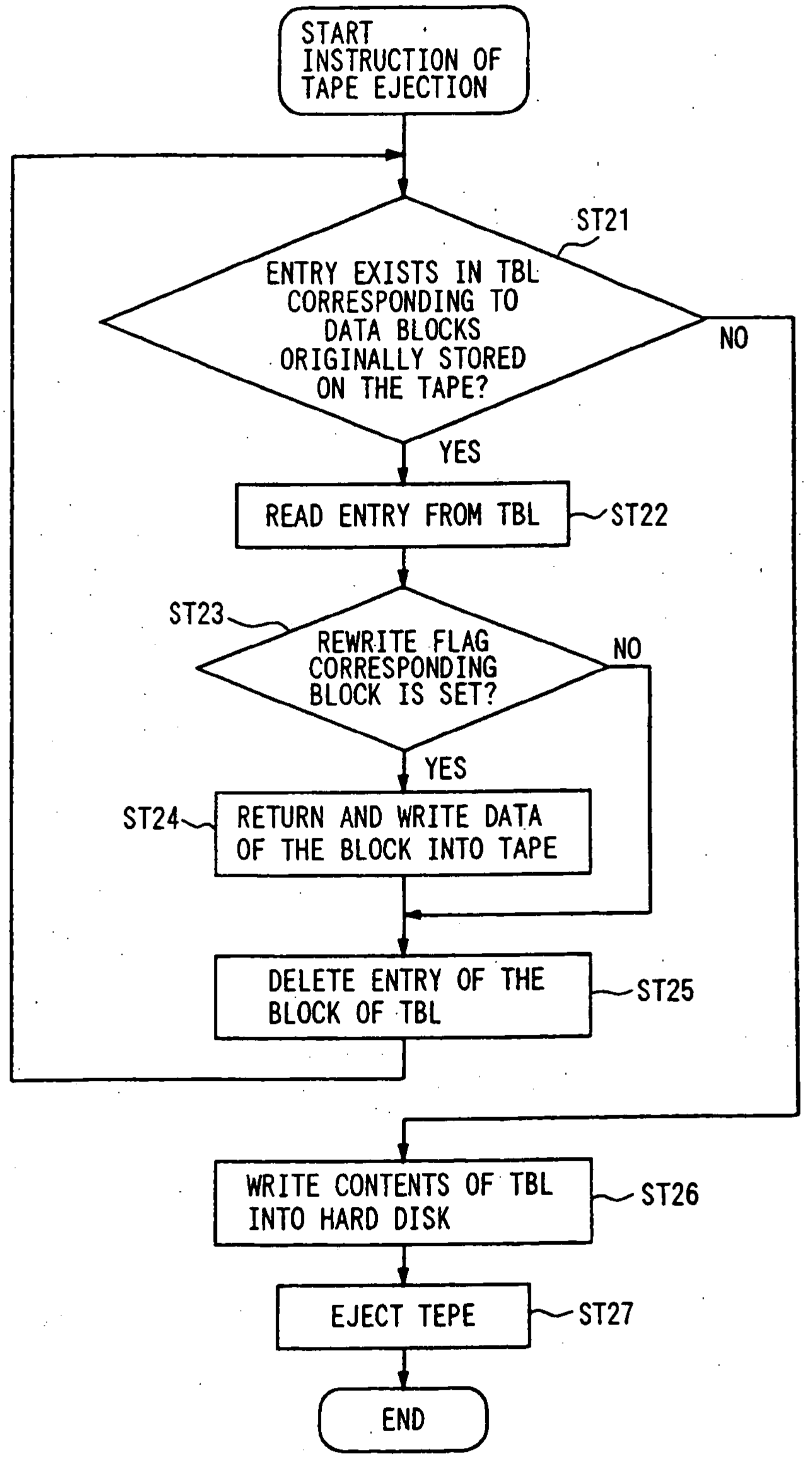

START
INSTRUCTION OF
TAPE EJECTION
ST21
ENTRY EXISTS IN TBL CORRESPONDING TO DATA BLOCKS ORIGINALLY STORED ON THE TAPE?
NO
YES
READ ENTRY FROM TBL
ST22
ST23
REWRITE FLAG CORRESPONDING BLOCK IS SET?
NO
YES
ST24
RETURN AND WRITE DATA OF THE BLOCK INTO TAPE
DELETE ENTRY OF THE BLOCK OF TBL
ST25
WRITE CONTENTS OF TBL INTO HARD DISK
ST26
EJECT TEPE
ST27
END

Fig. 7

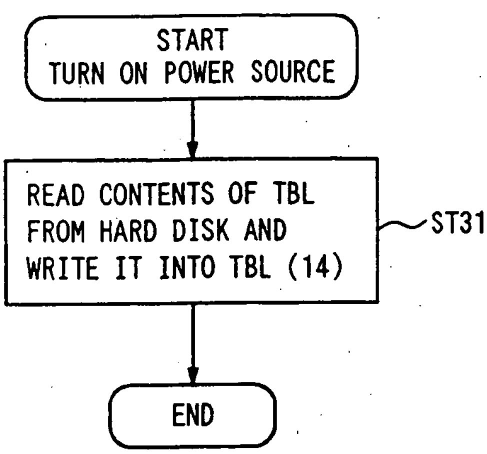
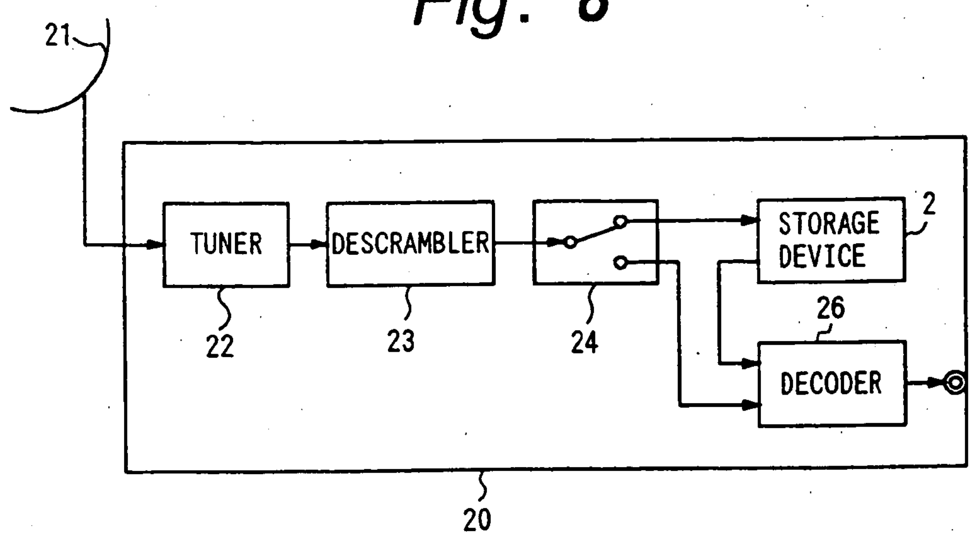

START
TURN ON POWER SOURCE
READ CONTENTS OF TBL
FROM HARD DISK AND
WRITE IT INTO TBL (14)
ST31
END

Fig. 8


21
TUNER
DESCRAMBLER
STORAGE
DEVICE
2
22
23
24
26
DECODER
20

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 4789

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-5 155 835 (BELSAN) 13 October 1992 * column 11, line 47-63 * * column 12, line 31-36 * * column 13, line 6-16 * * column 15, line 20-57 * * column 16, line 17-27 * * column 7, line 50-59 * -----	1-6	G06F12/08

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	31 October 1995	Weber, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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